



Yield regulation and economic analysis of collaborative forest (A study from Lumbini collaborative forest, Rupandehi, Nepal)

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General Note



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ABSTRACT

The sustainable forest management is a highly challenging issue in Nepal. There are limited studies associated to sustainable forest management. Thus, this research was objectively carried out in order to assess and compare growing stock in collaborative forest; compare estimated forest products of operational plan and extracted records; evaluate yield regulation in forests on the basis of Melard's French method and perform economic analysis of collaborative forest management. Random sampling was applied to carry out the sample in Lumbini collaborative forest of Rupandehi. Altogether 45 sample plots with a nested design; 20m*25m for tree, 10 m *10m for pole, 5 m *5m for sapling and 5 m *2m for seedling were allocated. The diameter and height were measured and regeneration counts were done in the sample plot. These data were analyzed using descriptive and inferential statistics. Growing stock (volume), Basal area per ha, regeneration per ha were calculated. The data were classified into DBH class 0-20, 20-40 and over 40 cm for evaluation under Melard's French method of yield regulation. In addition, economic analysis was done estimating B/C ratio, NPV and profit index.

The result showed that in harvested sub-block average number of seedling per ha was 28667 and sapling per ha was 5534 which were 36600 and 4460 in non harvested sub-block. The basal area of mother tree of harvested sub-blocks were found to be 6.32, 5.6, 3.2, 1.16 and 8.2 m²/ha. The basal area of tree of non harvested sub-blocks were found to be 18.4, 17.64, 15.04 and 27.08 m²/ha. The volumes of non harvested sub-blocks ASB10, ASB8, ASB6 and ASB4 was found to be 45.42 m³, 37.85 m³, 35.7 m³ and 75.16 m³ respectively; while volumes were 6.32 m³, 5.6 m³, 3.2 m³, 1.16 m³ and 8.2 m³ in harvested sub-blocks ASB1, ASB9, ASB7, ASB5 and ASB3 respectively. The t-test showed significant difference between the volume of tree and poles of harvested and non harvested sub-blocks at 5% level of significance. There was significant difference between timber (5527.35 m³) and fuel wood (3447.36 m³) volumes between the extracted value and estimated in operational plan. The B/C ration, NPV and profit index were 1.017, 283235.62 US\$ and 4.88 respectively. This research will be useful for forest manager and researcher.

Keywords: Collaborative forest, yield regulation, growing stock, regeneration, forest management, basal area

1. INTRODUCTION

Management can be based on conservation, economics, or a mixture of them. At the same time, the attention paid to sustainable forest management (SFM) has never been higher: More land is designated as permanent forest, more assessment, monitoring, reporting, planning and stakeholder involvement is taking place, and the legal frameworks for SFM are being widely adopted (Larrubia et al., 2015). Collaborative Forest Management is a concept introduced by the policy governing forest management in the year 2000, which is based on the Forest Act 1993; that the MoFSC has authority to make plan for the management of government managed forest. The past attempts in seventies, the forest management practices could not be fully implemented (Baral, 2002). The Revised Forest Policy, 2000 has an innovative concept for managing the "Government Managed" block forests of Terai region in a collaborative mode of management involving different stakeholders for management and benefit sharing CFM addresses more Terai specific issues such as inclusion of distant users (Ebregt, et al., 2007). In Nepalese context, CFM is an approach of sustainable forest management in collaboration with local people to achieve multiple benefits, maintaining ecological balance, generating economic returns and improving livelihood from government managed forests (CM WG, 2003). Later in the nineties, it was realized that the existing forest management practices were unsustainable (Pesonen, 1994; Pesonen & Rautiainen, 1995). Government of Nepal made attempts to implement scientific forest management through operational forest management plan but failed due to various reasons such as absence of guideline, innate fear of felling green trees (Bampton et al., 2007).

In the past, no scientific management of Terai forests was done except few silvicultural demonstration plots (Parajuli & Amatya, 2001). Therefore, the condition of growing stock is deteriorating resulting in the preponderance of old stock with very low growth than the potential growth and even good seed producing trees are scarce (Sah et al., 2004; Hill, 1999). Thus, large amount of timber, government royalty and subsequent employment opportunities are foregone every year (Subedi, 2013). Shelter wood system has been applied in forests of Nepal. The scheme of collaborative forest is based on block concept and sub-blocks are harvested annually in order to regulate the yield in the forest. However, there are some doubts in yield regulation such as: Does the expected yield guarantee the perpetuity in supply of forest products? What is annual income and expenditure from the forest? The stock is important preliminary requirement to estimate the yield. So, the first step is focused on the calculation of the growing stock. The growing stock of harvestable and non harvestable block is also an important dimension. Melard's French method (Quartier bleu) emphasizes young, medium and old on the ratio 1:3:5 to maintain the yield regulation and normality in the forest. Whether, the scientific forest management can guaranty this principle or are financial benefits attraction centre for the scientific forest management. Thus, this research was objectively carried out to assess and compare growing stock, compare the estimated forest products of operational plan and extracted records, evaluate yield regulation in forests on the basis of French method and perform economic analysis of collaborative forest management.

2. MATERIALS AND METHODS

The study was carried out in Lumbini Collaborative Forest, Rupandehi district. It is located between 24°40'32" N to 27°45'13"N latitude and 83°12' 55" E to 83° 14' 24" E longitude. The forest occupies an area of 1321 hectare and 204.2 hectare is protected as it is Chure area; total productive area is 1045 hectare. The forest is categorized as Sal and Terai hardwood forest. People living in 16 VDCs from Saljhandi to Aama in the south are the users of this collaborative forest (figure 1). The main species is *Shorea robusta* and other species are *Terminalia tormentosa*, *Terminalia bellerica*, *Adina cordifolia*, *Eugenia jambolana* and *Anogeissus latifolia*.

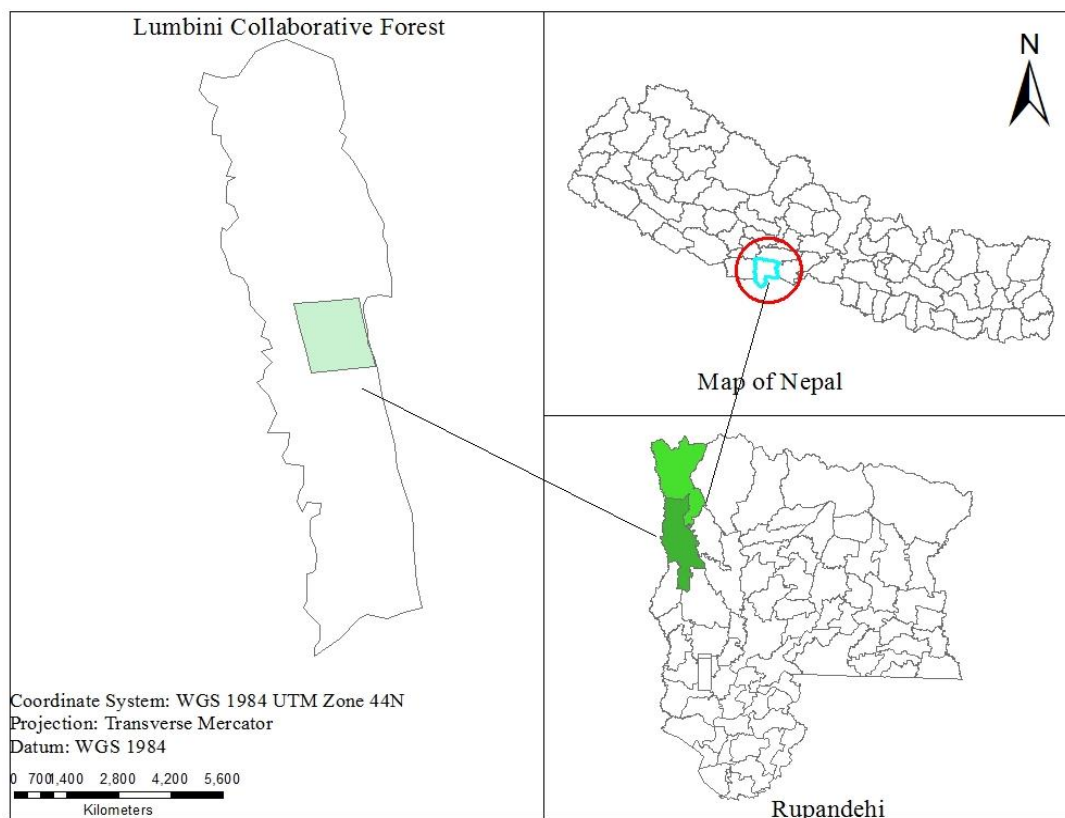


Figure 1 Map of study district Rupandehi showing Lumbini Collaborative Forest

The forest has been managed under Irregular Shelterwood system which is a compromise between shelterwood group system and group selection system (Prakash & Khanna, 1979). Simply, the trees of exploitable diameter are removed leaving behind the mother trees for seeds; the mother trees will be removed after regeneration is established. Regeneration felling is in the pattern of group system, but as the regeneration period is long, the crop produced is uneven-aged or irregular. Weeding, cleaning, thinning, pruning, girdling, climber or bush cutting and artificial planting are carried out as per the need.

The whole forest has been divided into eight periodic blocks for the purpose of the management of Sal forest under 10-year regeneration period and 80-year rotation period. Area control method of yield regulation has been adopted; so, each periodic block has been sub-divided into 10 annual sub-blocks (ASB) where regeneration felling activities will be carried out each year (LCFMG, 2014). The study was conducted in the Periodic Block (PB) I where regeneration felling operation was carried out in its five annual sub-blocks: ASB1, ASB3, ASB5, ASB7 and ASB9 from the year 2012/13 and 2016/17 respectively, while ASB2 sub-blocks was undergoing harvest operation during study. For the study purpose, nine annual sub-blocks were studied from Block I namely ASB1, ASB3, ASB5, ASB7 and ASB9 which were harvested and sub-blocks ASB4, ASB6, ASB8 and ASB10 which were non harvested (Figure 2).

The average maximum temperature is 36.16°C and the average minimum temperature is 22.5°C. During May- July the temperature reaches up to 42.5°C. It rains from June to October and the average yearly rainfall is 2220mm. During mid March to mid April hot air called 'Lu' occurs.

Sampling, Data collection and Analysis

As the forest area is homogenous random sampling was used for collecting data about forest growing stock, diameter distribution, number, height and species diversity. Sampling intensity of 2.8 was taken for sampling purpose. Out of 10 total sub-blocks of the periodic block I; 9 sub-blocks were undertaken for study. All sub blocks were studied except sub-block 2 (ASB2) as harvest operation was being carried out in that sub-block. Total 4 sub-blocks were non-harvested and 5 were harvested sub-blocks. In each sub-block 5 sample plots were taken.

The map of forest area and the periodic block I with sub-blocks was extracted from operational plan. The map of the area was prepared in GIS and a function called fishnet was applied to allocate sample points to the sub-blocks. At least five sample plots were allocated to each sub-block. The coordinates of each sample plot was uploaded on GPS and the instrument was used to navigate

the sample points in the field. Rectangular nested plots were established on the field for tree, pole, sapling and seedling respectively for sampling purpose.

Total of 45 sample plots were laid out in the forest. The sample technique was random sampling with sampling intensity 2.8. Sampling was carried out in rectangular nested plot of 20m*25m for tree, 10*10m for pole, 5*5m for sapling and 5*2m for seedling inside larger plot as shown in the figure given below.

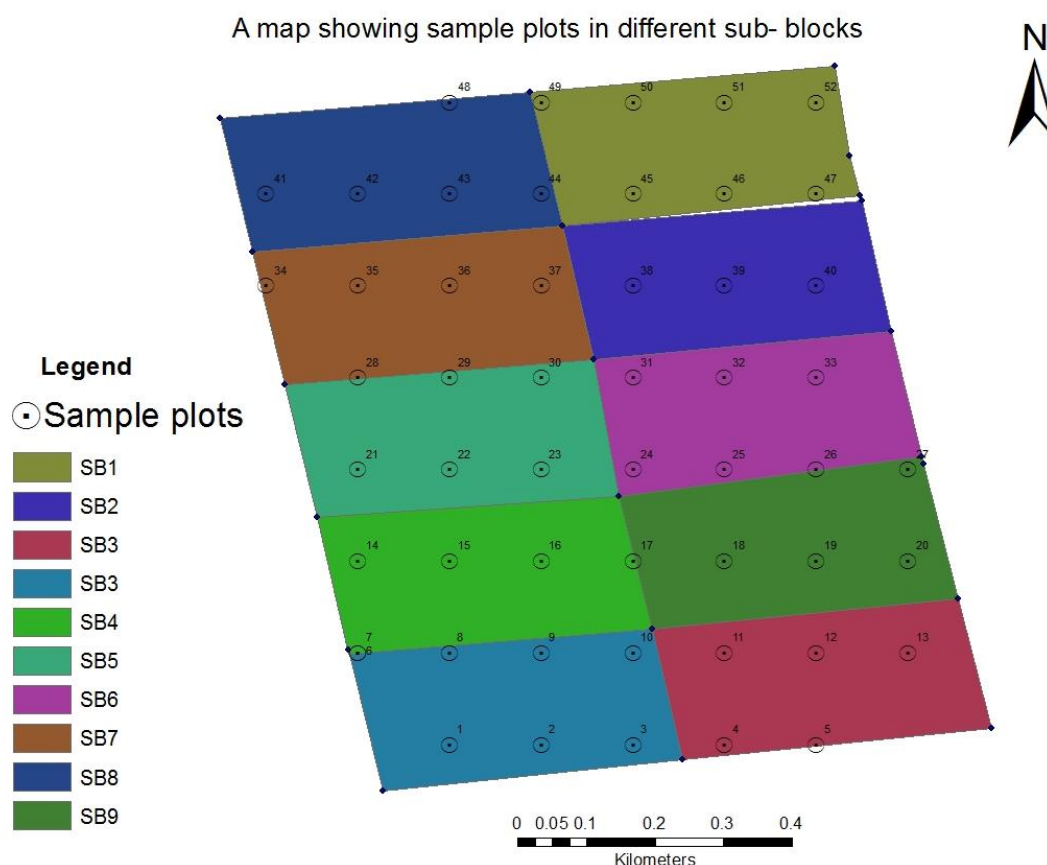


Figure 2 Map of periodic block I with sub-blocks

Dbh of trees, poles and sapling of each sample plot was measured using diameter tape (D-tape) and height of the trees/poles was measured using clinometers. The number of seedlings in each plot was also recorded in standard format.

Dbh and height of the poles/trees in the each sample plots was used to calculate timber volume. Number of seedlings, saplings and poles/trees per ha was calculated according to recorded data. The growing stock limited only on timber volume and number of plants.

$$\text{Growing Stock, GS} = \pi d^2/4 * h * f.f. * \text{Tree quality}$$

(Ref. CF resource inventory guideline, 2061)

Where, h= height and ff= form factor

$$BA = \pi d^2/4$$

Where, BA= basal area and d= diameter at breast height

To assess the sustainability of the forest Melard's French method or Quartier bleu method of yield regulation was used. It is based on the concept that a normal selection forest is like an even aged forest, the only difference being that the various ages, instead of occupying separate areas, were intermingled. The growing stock is divided into 3 diameter/ age classes; the old class with trees corresponding 2/3 to full exploitable diameter (DBH>40cm), the medium class (20-40cm) with trees ranging in diameter from 1/3 to 2/3rd of the exploitable diameter and the young class (DBH<20cm) with tree less than 1/3rd of the exploitable diameter (Ram

Prakash, 2006). The first two classes of the G.S is enumerated i.e. old and medium woods. If the volumes of old and medium classes are in the proportion 5:3; the forest is considered as normal.

The economic analysis was done employing Net Present Value (NPV), Benefit Cost Ratio (BC Ratio) and Profit Index (PI).

$$\text{NPV} = \text{Total present value} - \text{Total management cost}$$

$$= \left[\frac{\text{CF}_1}{(1+r)^1} + \frac{\text{CF}_2}{(1+r)^2} + \frac{\text{CF}_3}{(1+r)^3} + \dots + \frac{\text{CF}_n}{(1+r)^n} \right] - \text{Total management cost}$$

Where, r represents required rate of return (it is assumed 13%; Nepal Rastra Bank, 2017.04.04), and CF represents cash flow after tax.

$$\text{PI} = \frac{\text{NPV} + \text{Initial investment}}{\text{Initial investment}}$$

B/C = Benefit/Total management cost

3. RESULTS

The result shows growing stock; comparison of forest products of operation plan and extracted record; evaluation of yield regulation by Melard's French method and economic analysis of forests.

Growing stock of harvest and non harvested blocks in Lumbini Collaborative Forest

The volume of non harvested sub-blocks ASB10, ASB8, ASB6 and ASB4 were found to be 45.42 m³, 37.85 m³, 35.7 m³ and 75.16 m³ respectively. The volume of harvested sub-blocks ASB1, ASB9, ASB7, ASB5 and ASB3 were found to be 6.32 m³, 5.6 m³, 3.2 m³, 1.16 m³ and 8.2 m³ respectively. The number (N), basal area (BA) per hectare and the volume (V) of the tree, pole, sapling and seedling in the various sub blocks are depicted in the table 1 given below:

Table 1 Sub-block wise Growing stock

Sub-block	Tree			Pole			Sapling		Seedling	
	N	BA/ha (m ² /ha)	V (m ³)	N	BA/ha (m ² /ha)	V (m ³)	N	BA/ha (m ² /ha)	N	Remarks
ASB10	18	18.4	45.42	15	6	1.9	39	2.64	192	
ASB8	25	17.64	37.85	32	15.2	3.5	43	3.2	144	
ASB6	18	15.04	35.7	15	7.8	2.27	67	5.6	165	
ASB4	24	27.08	75.16	7	4.6	1.06	74	8.8	231	
ASB1	4	6.32	19.44	5	2	0.61	82	15.2	200	
ASB9	7	5.6	13.41	4	1.4	0.15	27	1.6	143	
ASB7	4	3.2	9.22	9	2.8	0.6	82	7.2	114	
ASB5	6	1.16	3.04	18	8	2.05	70	5.6	63	
ASB3	10	8.2	20.59	9	3.8	0.68	73	12	38	

Since the p-value was less than 0.05 applying independent t-test therefore, there is significant difference between the volume of tree of harvested and non harvested sub-blocks at 5% level of significance.

Moreover, since the p-value was less than 0.05 applying Mann-Whitney U test, therefore, there is significant difference between the volume of tree of harvested and non harvested sub-blocks at 5% level of significance.

Comparison of operational plan and extracted record of Lumbini Collaborative Forest

The estimated harvest from operational plan was compared with the harvest from extract record of past five years. The estimated harvest of timber from the forest from year 2013 AD to 2017 AD was found to be 1005.03 m³, 1800.26 m³ and 2122.04 m³ in past 3 years respectively; the actual harvest timber from the extract record was 789.64 m³, 669.62 m³, 628.45 m³, 698.69 m³ and 857.69 m³ respectively. The estimated harvest of fuel wood from the forest from year 2013 AD to 2017 AD was found to be 1009.26 m³, 1672.65 m³ and 1440.18 m³ in past 3 years respectively; the actual harvest of fuel wood from the extract record was 396.9 m³, 1156.68 m³, 629.37 m³, 737.1 m³ and 635.04 m³ respectively. The harvest was low as compared to the estimated harvest from operational plan (table 2).

Table 2 Comparison of operational plan and extracted record

Sub-block	Year	From OP		From extracted records		Difference (OP-extract record)			
		Timber (m ³)	Fuel wood (m ³)	Timber m ³	Fuel wood (m ³)	Timber		Fuel wood	
						Diff. (m ³)	Diff. %	Diff (m ³)	Diff %
ASB1	2013	1005.03	1009.26	789.64	396.9	215.39	27.28	612.36	154.29
ASB3	2014	1800.26	1672.65	669.62	1156.68	1130.65	168.85	515.97	44.61
ASB5	2015	2122.04	1440.18	628.45	629.37	1493.6	237.66	810.81	128.83
ASB7	2016	2122.04	1440.18	698.69	737.1	1423.35	203.72	703.08	95.38
ASB9	2017	2122.04	1440.18	857.69	635.04	1264.35	147.41	805.14	126.79
Sum		9171.42	7002.45	3644.08	3555.09	5527.35		3447.36	

Since the p-value was less than 0.05 applying independent t-test therefore, there is significant difference between timber of operational plan and extracted record at 5% level of significance. Moreover, since the p-value was less than 0.05 applying independent t-test therefore, there is significant difference between fuel wood of operational plan and extracted record at 5% level of significance.

Yield Regulation by French method in Lumbini Collaborative Forest

The growing stock was divided into 3 diameter/age classes; the old class with trees corresponding 2/3 to full exploitable diameter (DBH>40cm), the medium class (20-40cm) with trees ranging in diameter from 1/3 to 2/3rd of the exploitable diameter and the young class (DBH<20cm) with tree less than 1/3rd of the exploitable diameter. The ratios of the volume of the medium and old class of the harvested sub-blocks ASB1, ASB3, ASB5, ASB7 and ASB9 was calculated 2:108, 9:55, 1:2, 1:6 and 13:95 respectively. The ratios of the volume of medium and old class of non harvested sub-blocks ASB10, ASB8, ASB6 and ASB4 was found 3:43, 4:15, 15:65 and 41:316 respectively (table 3).

Table 3 Diameter class wise volume of different sub-block

Sub- block	Diameter class						Ratio (V)
	0-20 cm		20-40 cm		40-60 cm		
	N	V	N	V	N	V	
ASB1	86	0.18	1	0.43	4	19.44	1:2:108
ASB3	80	0.33	7	2.82	5	18.12	1:9:55
ASB5	86	1.51	3	1.25	5	2.34	1:1:2
ASB7	90	0.47	1	0.14	4	0.80	3:1:6
ASB9	30	0.12	3	1.61	5	11.38	1:13:95
ASB10	52	1.02	8	2.72	14	43.58	1:3:43
ASB8	68	2.17	14	8.06	16	31.48	1:4:15
ASB6	77	0.54	6	8.26	17	35.17	1:15:65
ASB4	77	0.17	11	5.20	17	70.84	1:31:416

Note: N denotes number per ha and V denotes volume per ha.

Economic Analysis of Collaborative Forest

This section shows income and expenses from various sources, B/C ratio, NPV and Profit index. The income from various income heads is depicted in the table 4:

The total income of Lumbini Collaborative Forest in between 2013-2017 AD was 1435500.12 US \$ out of which the contribution of the forest product was highest i.e. 76.26% or 10944689 US \$. The income from forest products was highest in the year 2017 AD; 386760.82 US \$ and least in the year 2014 AD i.e. 121554.09 US \$. The contribution of district forest office was second highest to the

income which was 19.11% (274399 US \$). The contribution of candidacy was least in total income of the forest which was 0.034% (495 US \$); which occurred only in the year 2016 AD.

Table 4 The annual income of collaborative forest

S. No.	Income Source	2013 (US \$)	2014 (US \$)	2015 (US \$)	2016 (US \$)	2017 (US \$)	Total (US \$)	Percentage
1	District Forest Office	33400	101000	55000	45000	39999.1	274399.1	19.11
2	Forest products	127293.26	121554.09	301742.74	157337.9842	386760.82	1094688.99	76.26
3	Wood selling			3300	6160		9460	0.659
4	Retail wood selling				4007	4724.5	8731.5	0.608
5	Forest entry				781.55	422.2	1203.75	0.084
6	Tender form selling		1580	1930	2780	1240	7530	0.52
7	Wood for burning dead				1480		1480	0.1
8	Candidacy				495		495	0.034
9	Others	12699.63	1272.6871				13972.32	0.973
10	Bank loan	470.2728	2299.8871	1201.96	6676.5618	12890.87	23539.55	1.64
	Sum	173863.16	227706.66	363174.70	224718.10	446037.5		

(Note: 1 US \$= 100 Nepali Rupees)

The contribution by wood selling, retail wood selling, forest entry, tender form selling and wood for burning dead was 9460 US \$, 8731.5 US \$, 1203.75 US \$, 7530 US \$ and 1480 US \$ respectively. The contribution of other source was 13972 US \$ and bank loan was 23539.55 US \$ to the total income of collaborative forest for past five years.

The expenditure from various sources

The expenditure from various expense heads is depicted in the table 5 below:

Table 5 The annual expenditure of collaborative forest

S.No.	Expenditure title	2013 (US \$)	2014 (US \$)	2015 (US \$)	2016 (US \$)	2017 (US \$)	Total (US \$)	Percentage
1	Forest development	28105.66	18745.75	21811.57	20947.63	12731.68	102342.29	14.39
2	Fuel wood, timber collection	20575.68	45683.11	36572.98	88785.14	52982.02	244598.93	34.38
3	Watch guard		5400	6918.75	88785.14	23638.22	130797.11	7.95
4	Public land management	9158.85				16697.51	16697.51	1.85
5	Office activation	1980	5513.71	7684.18	10457.88	8656.89	41471.51	5.83
6	Institutional development/ coordination		5813.98	3600	31418.7	9744.5	52557.18	7.39
7	Capacity building training	674	1138		1941	6333	9412	1.32
8	Extension/ Outreach		1507.4	2201.41	540	130	5052.81	0.71
9	Depot management		2030	3908.98	15554.35	21872.83	43366.16	6.09
10	Building construction			25790.7	4540.52		30331.22	4.26

11	Seedling production/ watch salary		4860	7472.8	12840		25172.8	3.54
12	Generator purchase	936					936	0.13
13	Fencing	3500					3500	0.49
14	Vehicle purchase				24250		24250	3.409
15	Monitoring	2083.05	12981.85	23655.1	7199.72	9223.35	55143.07	7.75
	Sum	73068.24	103673.8	139616.47	307260.08	162010	785628.59	

The total expenditure of Lumbini Collaborative Forest in between 2012-2017 AD was 785628.59 US \$ out of which the contribution of the fuel wood and timber collection was highest i.e. 34.38 % or 244598.93 US \$. The income from wood and timber collection was highest in the year 2016 AD; 88785.14 US \$ and least in the year 2013 AD i.e. 20575.68 US \$. The contribution of forest development was second highest to the expense which was 14.39 % (102342.29 US\$). The contribution of generator purchase was least in total income of the forest which was 0.13 % (936 US\$) which occurred only in the year 2013 AD.

The contribution by expense head such as monitoring, watch guard, institutional development/ coordination, depot management and office activation was 55143.07 US\$, 130797.11 US\$, 52557.18 US\$, 43366.16 US\$ and 41471.51 US\$ respectively. The expense head building construction, seedling production/ watch salary and vehicle purchase contributed 30331.22 US \$, 25172.8 US\$ and 24250 US\$ respectively. The least contribution was made by expense head such as Public land management, Capacity building training , Extension/ Outreach and Fencing which was 16697.51 US\$, 9412 US\$, 5052.81 US\$ and 3500 US\$ respectively.

Trend of income and expense in past five years

The income and expenses of the collaborative forest from the records for the past five years were studied. The expense is low as compared to the income of the collaborative forest. Only in the fiscal year 2016 AD the expenses are slightly higher than that of the income. The overall income of past five years is 1435500 US\$ and expense is 711351 US\$ (figure 3).

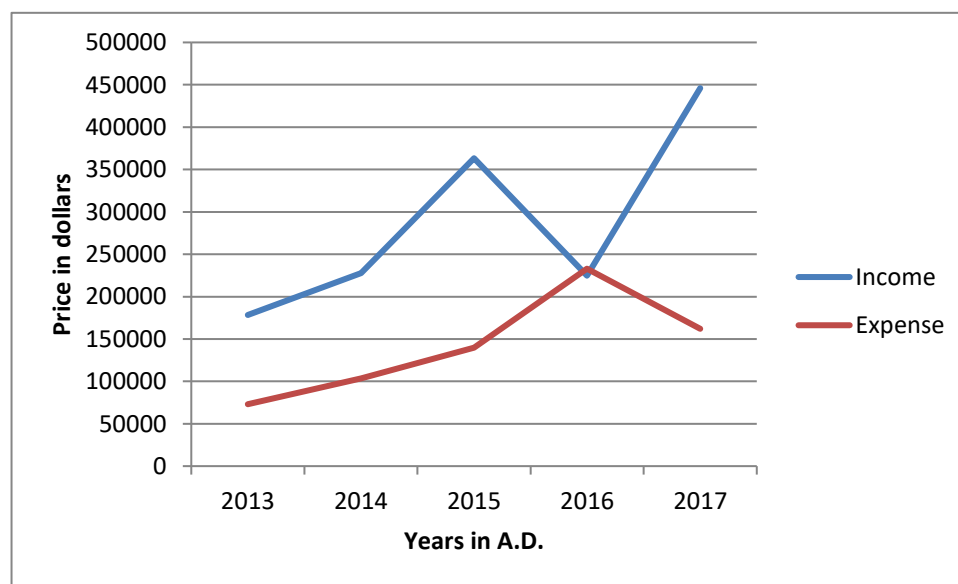


Figure 3 Trend of income and expense

The benefit-cost ratio from 2013 till 2017 AD was found to be 1.379, 1.196, 1.6, 0.035 and 1.75 respectively. All the value of B/C ratios is acceptable except that of the year 2016 AD.

Benefit cost of the past five years (2013-2017 AD) was found to be 1.017. The Net present value from the year 2013-2017 AD was calculated to be US \$.283235.62 (fig. 4).

Note: Interest rate is assumed as 13%; (Nepal Rastra Bank, 2017.04.04)

The profit index of the collaborative forest was calculated to be 4.88.

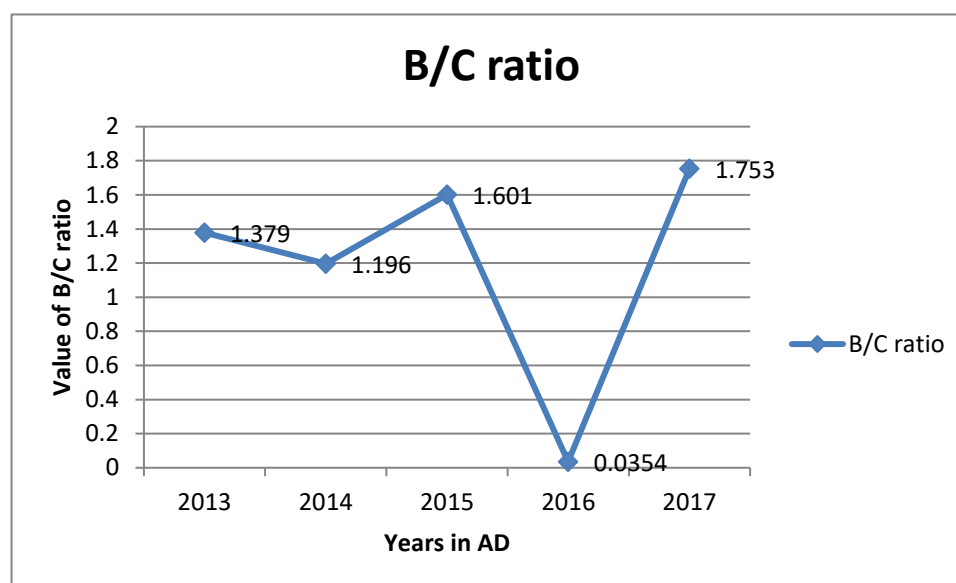


Figure 4 Benefit cost analysis of past five years

4. DISCUSSIONS

Study done by van Gardingen, Valle and Thompson (2006) the composition of the managed forest is likely to differ significantly from that observed in primary forest. According to state of Nepal's Forests, the national average of basal area of tree is 17.08 m²/ha and for volume of tree is 161.66 m³/ha for Terai. The average basal area per of tree of non harvested sub-block is slightly more than national average for Terai.

According to forest resource inventory guideline -2005 (DoF, 2005); growing stock is good if growing stock per ha is >200 m³ and growing stock is medium if 50m³ – 200m³ per ha. The volume of non harvested sub-block ASB10 is 75.16 m³ which was medium and of sub block ASB8, ASB6 and ASB4 was found to be poor. According to Walter's (2005) research on "Ecological effects of small-scale cutting of Philippine mangrove forests" there is a significant difference between diameters and basal area of uncut and cut forest plots. Diameter is directly proportional to volume; so my results are similar to his findings. According to research by Sullivan, et al. (2001) on "Influence of variable retention harvests on forest ecosystems" there is a significant difference of diameter on clear cut, patch cut, single seed tree, group seed tree and uncut forest. Diameter is directly proportional to volume so my results are similar to his findings.

The ratios of the volume of the medium and old class of the harvested sub-blocks ASB1, ASB3, ASB5, ASB7 and ASB9 was 2:108, 9:55, 1:2, 1:6 and 13:95 respectively. In non harvested sub-blocks ASB1, ASB3, ASB7 and ASB9 the volume of old class (V_o) is much higher than the volume of medium class (V_m). The mother tree should be examined and then lower diameter trees will be transferred to V_m in due course of time to adjust the proportion to 3:5. In the sub-block 5 (ASB5) the ratio of volume of old class and medium class is deficient and nothing shall be removed except dead and dying trees.

The ratio of volume of medium and old class of non harvested sub-blocks ASB10, ASB8, ASB6 and ASB4 was found 3:43, 4:15, 15:65 and 41:316 respectively. In the sub-blocks ASB10, ASB8, ASB6 and ASB4 the volume of old class (V_o) is much higher than the volume of medium class (V_m). The tree should be examined and then lower diameter trees will be transferred to V_m in due course of time to adjust the proportion to 3:5.

The contribution of the forest product to the total income (1435500.12 US\$) of Lumbini Collaborative Forest was highest i.e. 76.26% (10944689 US\$). From study of Kanel and Niraula in CFUGs of 12 districts conducted in 2004 AD; it was found due to the higher value of Terai forests and volume of production, overall Terai CFUGs make up 35% of forest products sales from all CFUGs. The income of Lumbini Collaborative is found higher than the study conducted by Kanel and Niraula (2004) due to the yearly extraction of over mature Sal timber and sales of extracts.

The benefit-cost ratio from 2013 till 2017 AD was found to be 1.379, 1.196, 1.6, 0.035 and 1.75 respectively. All value of B/C ratio is greater than 1 and acceptable except that of the year 2016 AD. This means that the management is in profit except the year 2016 AD. Benefit cost of the past five years was found to be 1.01. The overall benefit cost ratio is profitable. The Net present value was calculated as 283235.62 US\$. The NPV is higher than 1 so it's also profitable. The profit index is 4.88 which means the returns from the scientific forest management is highly profitable.

According to study by Bhoj Raj Pathak and Xie Yie in 2017 (Pathak, Yie, 2017) on Tilaurakot Collaborative Forest, B/C ratio of year 10 years; 2006/07 AD to 20015/16 AD was found to be 5.4. Whereas, NPV was highest 126669.3 US\$ in the year 2009/10 AD and NPV was lowest in the first year 23417.8 US\$ i.e 2006/07 AD. The NPV (283235.62 US \$) of Lumbini Collaborative Forest resembles the lowest NPV of the year 2006/07 AD, B/C ratio (1.01) was found pretty low compared to the results of Tilaurakot Collaborative Forest.

5. CONCLUSION AND RECOMMENDATIONS

- There was significant difference between the volume of trees and poles of harvested and non harvested sub-block.
- Similarly, there was significant difference between timber and fuel wood of operational plan and extracted record.
- In the sub-blocks ASB1, ASB3, ASB7, ASB9, ASB10, ASB8, ASB6 and ASB4 the volume of old class (v_o) was much higher than the volume of medium class (v_m). In the sub-block ASB5 the ratio of volume of old class and medium class was deficient.
- The major source of income was forest products and major sources of the expenditure are fuel wood and timber collection. The overall BCR, NPV and the profit index were found high.
- The income and expenses of the collaborative forest should be audited yearly and analyzed in order to improve the economic status of the CFUG and to maintain transparency in upcoming days.

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